

PATENT SPECIFICATION



Convention Date (United States) : Feb. 25, 1939.

538,444

Application Date (In United Kingdom) : Jan. 31, 1940

No. 1943/40.

Complete Specification Accepted : Aug. 5, 1941.

COMPLETE SPECIFICATION

Improvements in or relating to Continuously Acting Centrifugal Filters

I, AUGUST HENRY SCHUTTE, a citizen of the United States of America, of The Lumus Company, Room 1250, 420 Lexington Avenue, City and State of New York,

5 United States of America, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

10 This invention relates to improvements in the method of and apparatus for continuously separating liquids from solids by centrifugal filtration, and in one form of embodiment is an improvement on the invention disclosed in Specification No. 526,744.

I have heretofore disclosed a method of separating wax from waxy mixtures by 20 the emulsification of the waxy mixture with an immiscible and non-solvent material and thereafter cooling the emulsion to precipitate out certain portions of the wax, after which separation was 25 accomplished in a suitable filter, preferably of the centrifugal type.

My present invention relates to an improvement on such invention and more particularly relates to the use of a continuous centrifugal filter by which the 30 operation can be rendered continuous.

A general object of the invention is to provide a centrifugal filtering device which is adapted to discharge a filter cake 35 autogenously and continuously while filtration and washing is being carried out therein, and without the addition of moving parts to a machine of the conventional batch type.

40 A particular object of my invention is to provide a continuous centrifugal filtering operation to continuously filter emulsions of waxy mixtures for the separation of various melting point constituents 45 therefrom.

A still further object of the invention is to provide an improved method of centrifugally filtering and washing a slurry mixture of such density that additional 50 slurry may be continuously introduced to one part of the filter and a cake may be continuously removed from another part of the filter without the necessity of any

moving parts other than the rotor and without resort to scraping or propelling 65 devices. In this device the cake removal is self-motivating.

According to the present invention there is provided a method of continuously 60 filtering a slurry in a centrifugal filter which comprises the steps of applying the slurry to a part of the centrifuge near the bottom, reducing the specific gravity of the slurry by removal of the liquid portion thereof, and propelling the filter cake out 65 of the filter by continuous displacement of additional slurry of a higher specific gravity.

The invention also provides a method of 70 continuously filtering a slurry containing solid particles lighter than a liquid constituent thereof, which comprises continuously feeding the slurry to a basket centrifugal filter rotating within a filtrate collection housing, rotating said filter to 75 form a cake thereon by the centrifugal removal of filtrate through the solid particles and through the filter medium, said cake being formed on and being 80 directly supported by the filter medium, removing the filtrate without permitting its accumulation in the housing, and continuously discharging said cake autogenously substantially parallel to the axis of rotation as an annular mass while supported by the filter medium due to the 85 resultant of forces resulting from the difference in densities of the cake and slurry.

The invention further provides a continuous centrifugal filter having a perforated rotating basket, a foraminous filter medium on the wall of said basket, a fixed filtrate collection housing surrounding said basket, means to feed a slurry 95 into the basket adjacent one end thereof, means to rotate the basket to force the liquids through said filter medium under centrifugal force and to form a filter cake thereon, means on the end of the basket 100 opposite the feed extending inwardly to limit the thickness of the cake formed on the filter medium, means to move the filtrate from the housing, said cake autogenously discharging from said housing 105 during the continuous of feed,

The invention still further provides a centrifugal filter comprising a rotating foraminous filter medium, means to introduce a slurry having a high proportion of liquid to solids at one part thereof, the foraminous filter medium being adapted to be rotated to discharge the liquid through the filter medium and form a filter cake thereon, and means to introduce a second slurry of a less liquid quality to a part of the filter medium where the cake is of substantially equivalent quality.

The invention will now be more fully described with reference to the accompanying drawings, in which

Figure 1 is a typical flow sheet for the wax treatment together with diagrammatic details of the centrifuge apparatus;

Figure 2 is a diagrammatic showing of a modified form of flow arrangement.

As more particularly described in my prior application above referred to, the separation of different melting point waxes from a waxy mixture may be carried out by forming an emulsion of the waxy mixture with a non-solvent immiscible material, more particularly water. As shown in the drawing, the waxy mixture is carried in a suitable jacketed tank 10 which is provided with a steam connection 11 for the purpose of maintaining the wax mixture at the desired temperature. The water or other non-solvent and immiscible liquid may be conveniently carried in a similar tank 12, which is jacketed to receive steam from the line 13. The wax and the water are formed into an emulsion in the correct proportions by passing through the proportionating pump 14, and then being passed through a suitable type mixer 15, either with or without the addition of air or other inert gaseous material at 16. The mixer 15 is provided with a bypass 17 and normally pumps against a relief valve 18 so that an emulsion is made.

This emulsion is in the form of a foamy material which resembles in appearance whipped cream or shaving lather which is sufficiently stable to permit the subsequent treatment. Temperature control is preferably obtained by indirect heat exchange or by the direct introduction of cold water as at 19, which is sufficient to solidify the higher melting point waxes in the emulsion. The emulsion is discharged at 20 into the separator generally indicated at 22.

The separator 22 is preferably a centrifugal basket type filter having a perforated rotating basket 36 lined on the interior with a foraminous filter medium. This is rotated at such a speed that a high separating or filtering force is obtained. With the particular wax treated as herein-

after described, it is convenient to make this filter medium of woven wire or filter duck, and it is possible to obtain a filter force in the range of 500 to 1000 times gravity. As the filtering force is gravitational by nature, the entire cake is subjected to the force without an external crushing action, and the cake formed is a fine grained, free-filtering porous mass, which is permeable to wash liquid. The cake is evenly dried and washing can be readily accomplished on this type of filter.

The wash liquid may be applied in either or both of two places as indicated, the wash lines 23 and 24 being suitably connected to steam and water lines 25 and 26 respectively, in such manner that accurate temperature control can be had.

The separator 22 is also preferably jacketed, with a heating medium introduced at 28 and 29, and with the liquid taken off at 30 and 31. Steam and water may also be introduced around the cake removing channel 33 as by the line 34.

In the operation of the separator 22, a filtrate will be removed through the foraminous basket 36 and some of the filtrate collected in the lower chamber 37 of the separator. This filtrate may be collected in the filtrate tank 38, which is conveniently jacketed and heated as by line 39 so that the filtrate can be removed through the line 40.

If desired, a partition 42 may be used part way up the side wall of the filter basket 36, which tends to divide the filter into two sections, forming an upper filtrate compartment 44. The filtrate in this section may be removed through the line 45 and collected in the wash tank 46, which is similarly jacketed and heated from the line 39 so that the product may be removed at 47. In this case, however, the collected material may be an intermediate wax as will hereinafter be described.

Ordinarily a centrifugal filter of the type described has but a very limited capacity due to the volumetric limitations of the diameter, height and effective thickness of the cake. After a few minutes required to fill the machine, and a few minutes' operation for washing the cake, it is then necessary to remove the material as by an internal scraper. Thereafter operations are again resumed so that the effect is of a batch nature.

I have now found, however, that if I continue to introduce the emulsion of wax and immiscible non-solvent liquid, the cake builds up to a certain extent and because of the controlled nature of the cake, it will discharge over the top and can be collected in the trough 33, melted and removed from the machine at 50, such

cake being carried into a cake tank 52. It is, of course, to be understood that if melting of the cake were undesirable, mechanical, hydraulic, or other means could be used for this cake removal.

This continuous discharge of cake out of the filter represents a new phenomenon not heretofore known to me, and appears to be due to the fact that the slurry introduced through the line 20 near the bottom of the separator 36, is heavier than the material that is discharged over the top. It is to be understood that the emulsion contains not only solidified wax, but also a liquid wax and water. The liquid wax penetrates the foraminous filter basket and is removed. Similarly, a substantial part of the water of the emulsion, as well as the wash water introduced at 23 and 24, is also discharged through the foraminous basket. The filter cake resulting, therefore, is of less specific gravity than the emulsion because it is porous as a result of the emulsion. It is also semi-plastic so that it will tend to move upward due to the differential of forces acting in this direction. The lip on the basket 36 which controls the thickness of the cake does not prevent its discharge which is controlled solely by the rate of slurry feed as it is a direct volumetric displacement.

In experiments which I have conducted with a 109° F. melting point slack wax charge containing 30 to 35% oil, I have formed a 1—1/2" cake on a centrifugal filter of 10" in diameter, which was operated at 1900 to 2300 R.P.M. From such machine, I have continuously collected in the trough 33 a wax of 122—1/2° F. melting point containing 2 to 3% oil. Furthermore, I have found, by introducing feed containing an insoluble dye that the feed material penetrates the previously deposited wax cake at the bottom and pushes it up by volumetric displacement. A cross section of the cake so formed shows that the new material takes a parabolic form with the axis vertical, and on the outer wall adjacent the foraminous lining. This shows the resultant of forces which continuously moves the filter cake through the filtering zone, past the washing zone and eventually out into the trough 33.

I find that I can definitely control the upward movement of the filter cake and can so control the time factor that I can continuously filter at the equivalent rate of 1200 barrels per day of a slack wax of the above type in a filter 60" in diameter and 36" high. The rate of travel on such a machine is approximately 3.6" per minute.

It will be apparent that the continuous operation of such a device is a material

improvement over the batch or semi-continuous process and, inasmuch as there are no moving parts except the basket itself, and as there is no scraper or other device which might tend to harm the rotating basket, I am able to obtain very successful yields with a very minimum of equipment, labor and upkeep. The conditions can be adjusted entirely external of the apparatus so that the character of discharged material may be controlled. The intermediate wax drawn off at 47 is a result of this operation and such intermediate wax may be returned if desired.

It will also be apparent that the invention can be carried out with any filter cake provided that the slurry is of a greater density than the resulting porous filter cake so that the slurry will displace the cake at a desired rate. The resultant of forces due to the differential of specific gravity of the slurry and cake must be sufficient to overcome the resistance of motion of the cake.

This invention may be applied to the continuous filtration of sewage sludge, soybean and other vegetable oil extraction, fatty acid separation, cereal flour extraction, drying of chemical salts such as glaubers salts, etc., extraction of starch, and other operations in which the conditions are as specified.

A modified flow diagram for the recycling of intermediate wax is shown in Figure 2. In this arrangement, provision is made for withdrawing this intermediate wax cake removed from the first operation, and introducing it to a second filter at a predetermined point substantially adjacent a zone of similar quality of cake for further filtration without contamination.

The filtrate from the second machine, instead of being mixed with the primary charge, with resulting oil solubility loss effect, is separately emulsified and fed to the primary machine at a point above the primary charge feed. This is analogous to feeding a fractionating tower above a stripping section and below the fractionating decks.

More particularly, the apparatus is adapted to treat slack wax for the purpose of separating desired melting point waxes. In this form of embodiment of the invention, the slack wax feed at 60 is conveniently mixed with air or inert gas at 61 and water introduced at 62, and is emulsified by mixer 63 which is conveniently a pump which, because of valve 64, recirculates the mixed materials through bypass 65. The resulting emulsion is discharged at 66 to the first centrifugal filter generally indicated at 67.

The filter 67 is of the type heretofore described and is conveniently jacketed for

desired temperature control. It is provided with the rotating filter cage 68 into the bottom of which the wax emulsion is introduced. The cake is continuously discharged by the autogenous displacement of the light cake by the relatively heavy slurry and is removed from the trough 69 and collected in crude scale tank 70. The finished foots oil is removed at 71. A filtrate can be removed at 72 from the upper portion of the filter if the partition 73 is used. Washing of the filter cake at 74 and 75 is usually found desirable.

The crude scale wax collected at 70 is preferably treated again by re-emulsifying with inert gas or air at 78 and immiscible and non-solvent liquid or water at 79 by mixer 80 and the emulsion discharged through valve 81 into the second filter generally referred to at 82. This is similarly jacketed to facilitate the temperature control and is provided with wash nozzles at 83 and 84.

In the second filter, the finished wax is removed as cake at 86 and the filtrate is removed at 87. The temperature control and wash medium permit precise control of the quality of the final wax.

The filtrate from the second filter at 87 and from the first filter at 72 are then combined and emulsified with an inert gas, such as air, at 90 and with a non-solvent and immiscible liquid, such as water, at 91 and passed through the mixing device 92, and the emulsion, which discharges through valve 93, is discharged into the first filter through line 94. In this case, however, this emulsion which is recycled or returned is introduced at a point somewhat higher than the slack wax emulsion. A disc 95 maintains this feed at the desired level.

As previously pointed out, the emulsion which is recycled or returned, having been partially freed of foots oil in the first filtration, is not subject to oil solubility loss as it is above the point of initial feed and has substantially the same characteristics as the filter cake at such zone. This cycle of operation not only adds to the complete separation of finished wax from foots oil, but when accomplished as here pointed out, there is no tendency to contaminate the foots oil and maximum yields, with a minimum of circulation, are possible.

As an example of the products which I have obtained on a two-stage operation, I show the following: Feeding 110° F. melting point slack wax; the finished foots oil from the first machine is 85° to 90° F. melting point. The crude scale wax is about 124° F. to 126° F. melting point, and from this is produced a finished wax having the desired 133° F. to 133.5° F.

melting point.

Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is:—

1. A method of continuously filtering a slurry in a centrifugal filter which comprises the steps of applying the slurry to a part of the centrifuge near the bottom, reducing the specific gravity of the slurry by removal of the liquid portion thereof, and propelling the filter cake out of the filter by continuous displacement of additional slurry of a higher specific gravity.

2. The method according to claim 1 which comprises filtering the slurry to form a filter cake and to discharge a filtrate, said cake being porous and lighter than the slurry, whereby the volumetric displacement of the cake out of the filter is accomplished by the continuous inflow of slurry.

3. The method of continuously filtering a slurry containing solid particles lighter than a liquid constituent thereof, which comprises continuously feeding the slurry to a basket centrifugal filter rotating within a filtrate collection housing, rotating said filter to form a cake thereon by the centrifugal removal of filtrate through the solid particles and through the filter medium, said cake being formed on and being directly supported by the filter medium, removing the filtrate without permitting its accumulation in the housing, and continuously discharging said cake autogenously substantially parallel to the axis of rotation as an annular mass while supported by the filter medium due to the resultant of forces resulting from the difference in densities of the cake and slurry.

4. The method according to claim 1 or 3 adapted for separating liquid from solid parts of a mixture, e.g., separating a high melting point wax from lower melting point waxes and/or "foots" oil which comprises emulsifying the mixture with a non-solvent and immiscible fluid, cooling said emulsion to solidify a part of the solids in the emulsion or part of the wax centrifugally filtering the emulsion, thereby forming a filter cake such as a cake of a high melting point wax and continuously displacing said filter cake autogenously.

5. The method according to claim 4, in which the filter cake is re-emulsified, cooled and centrifugally filtered to produce a high melting point wax, the filtrate being "foots" oil.

6. A continuous centrifugal filter having a perforated rotating basket, a foraminous filter medium on the wall of said basket,

a fixed filtrate collection housing surrounding said basket, means to feed a slurry into the basket adjacent one end thereof, means to rotate the basket to force the liquids through said filter medium under centrifugal force and to form a filter cake thereon, means on the end of the basket opposite the feed extending inwardly to limit the thickness of the cake formed on the filter medium, means to move the filtrate from the housing, said cake autogenously discharging from said housing during the continuous inflow of feed.

7. A centrifugal filter according to claim 6 comprising a slurry inlet and a cake discharge, said filter medium rotating at such a speed that the liquid material is separated from the solid material in the slurry, and means to control the feed of the slurry so as to control the rate of discharge of the cake whereby controlled dryness is obtained.

8. A centrifugal filter comprising a rotating foraminous filter medium, means to introduce a slurry having a high proportion of liquid to solids at one part thereof, the foraminous filter medium being adapted to be rotated to discharge the liquid through the filter medium and form a filter cake thereon, and means to introduce a second slurry of a less liquid quality to a part of the filter medium where the cake is of substantially equivalent quality.

9. A continuous centrifugal filter according to any one of claims 6-8, including a rotatable foraminous filter medium and a shell which is divided into separate portions along the axial length of the filter medium whereby separate filtrates may be removed therefrom.

10. A centrifugal filter according to claim 9 in which the filter medium is elongated,

said filter having a multi-part compartment axially spaced with respect to said filtering medium whereby independent heating of the respective parts can be provided.

11. Apparatus for separating a high melting point wax from "foots" oil in slack wax which comprises a mixer to form an emulsion of the slack wax, centrifugal filter means to separate a crude scale wax from the "foots" oil, a partition to collect a filtrate, a mixer to emulsify the crude scale wax, centrifugal filter means to filter said emulsion and to form a finished high melting point wax and a further filtrate, a mixer to emulsify the filtrate from both filters, and valued means to introduce or return said emulsion to a zone in the first filter spaced from the feed of the slack wax emulsion, and at a zone of comparative equality with respect to the filtrable liquid in the emulsion which is recycled or returned and in the filter cake present on the filter.

12. Method for continuously separating liquids from solids by centrifugal filtration substantially as herein set forth.

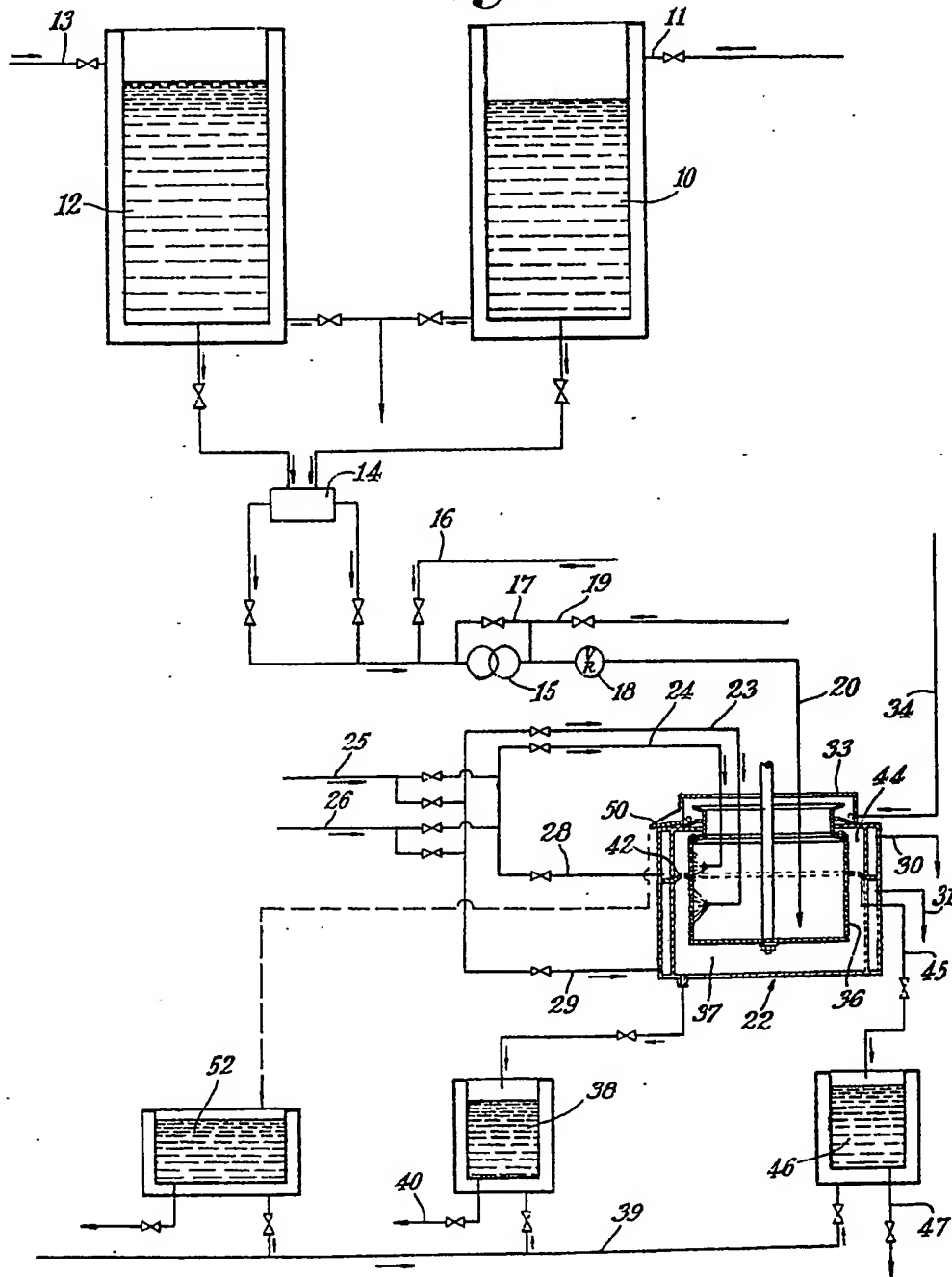
13. Apparatus for continuously separating liquids from solids by centrifugal filtration, constructed, arranged and adapted to operate substantially as hereinbefore described with reference to the accompanying drawings and for the purpose specified.

Dated this 30th day of January, 1940.

For AUGUST HENRY SCHUTTE,
Stevens, Langner, Parry & Rollinson,
Chartered Patent Agents,

5-9, Quality Court,
Chancery Lane, London, W.C.2, and at
120, East 41st Street, New York,
United States of America.

Fig. 1.



[This Drawing is a reproduction of the Original on a reduced scale.]

Fig. 2.

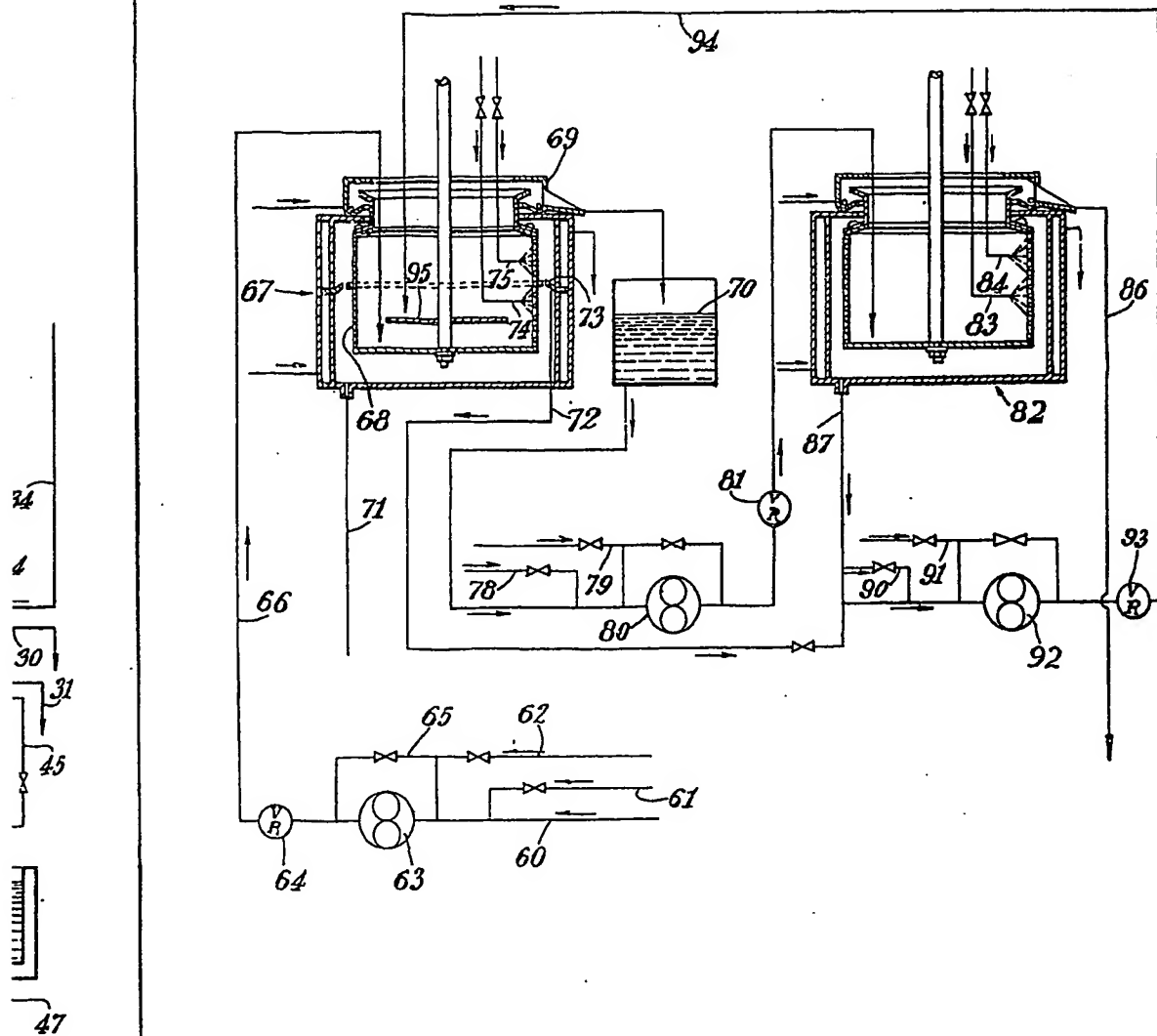


Fig. 1.

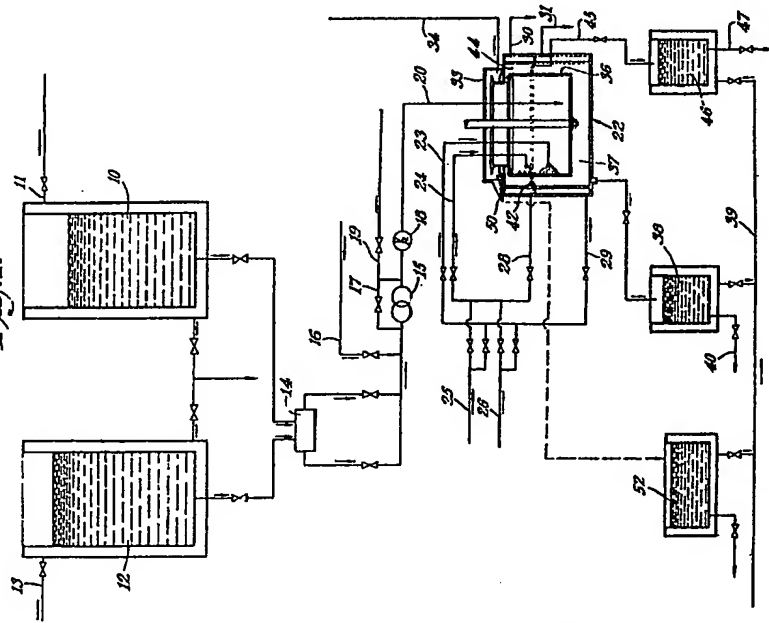
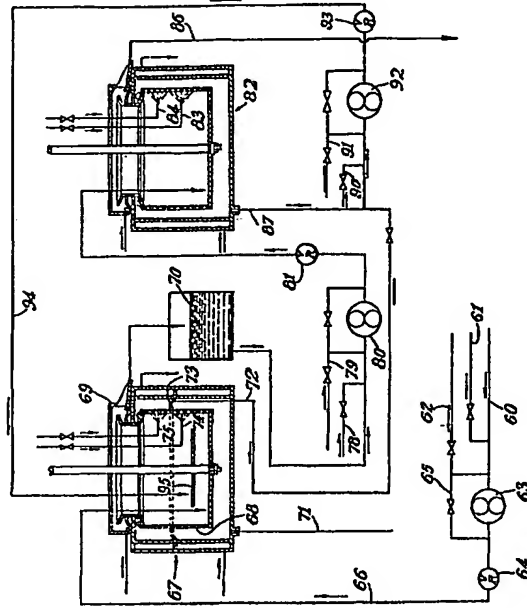


Fig. 2.



**This Page is Inserted by IFW Indexing and Scanning
Operations and is not part of the Official Record**

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ **BLACK BORDERS**
- ☐ **IMAGE CUT OFF AT TOP, BOTTOM OR SIDES**
- ☐ **FADED TEXT OR DRAWING**
- ☐ **BLURRED OR ILLEGIBLE TEXT OR DRAWING**
- ☐ **SKEWED/SLANTED IMAGES**
- ☒ **COLOR OR BLACK AND WHITE PHOTOGRAPHS**
- ☐ **GRAY SCALE DOCUMENTS**
- ☒ **LINES OR MARKS ON ORIGINAL DOCUMENT**
- ☐ **REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY**
- ☐ **OTHER:** _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.